Diffusion Coefficients in Supercritical Fluid - Solid Binaries

A.B. Chelico and M.A. Trebble

Department of Chemical and Petroleum Engineering

University of Calgary

Calgary, T2N 1N4 Canada

Continuous weight loss measurements of a solid solute sphere in the flow path of a supercritical fluid solvent directly quantify the mass flux of the subliming solid solute. This mass flux and appropriate boundary conditions solve the rigorous mass transfer equation that is appropriate for the given geometry (solid sphere in a cylindrical flow path). The solution of the mass transfer equation leads to a diffusion coefficient through a back calculation.

Supercritical fluid solvents for the weight loss experiments included ethane and carbon dioxide. Solid solutes included naphthalene, tetracosane, octacosane, and dotriacontane. All experimental conditions were above the critical point of the solvent in each case. Temperatures varied from 35 to 55° C and pressures from 5000 to $20\,000$ kPa.

The diffusion coefficient values were around $1x10^{-8}$ m²/s. The reason for the relatively high diffusivities stems from the high kinematic viscosities that are inherent in the supercritical phase. Supercritical fluids characteristically have low vapour like dynamic viscosities and high liquid like densities. The combination of these two properties makes supercritical fluids ideal solvents from a mass transfer point of view.

Solubilities are also relatively higher at supercritical conditions. This implies a greater capacity for extraction for a supercritical solvent.